



# Biofidelity Evaluation of WorldSID-05F with Mod Kit and SID-IIs BLD

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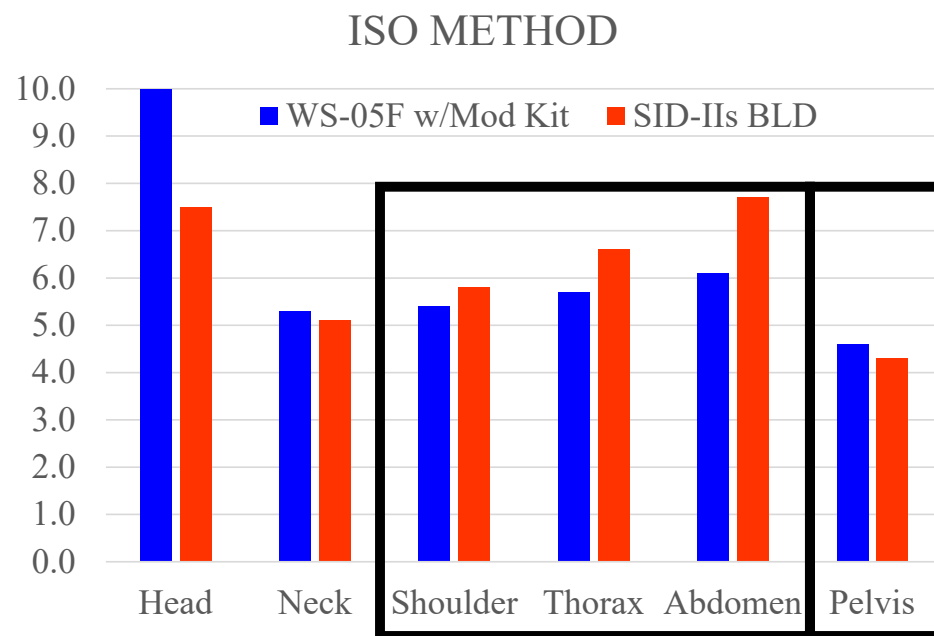
# Biofidelity Using ISO 9790 Ranking System



Higher  
score  
is  
better

Biofidelity Score	ISO Biofidelity Rating
$8.6 \leq B \leq 10$	Excellent
$6.5 \leq B < 8.6$	Good
$4.4 < B < 6.5$	Fair
$2.6 \leq B < 4.4$	Marginal
$0.0 \leq B < 2.6$	Unacceptable

Overall score	
WS-05F	SID-IIs
6.2	6.2



WorldSID-05F with Mod Kit biofidelity needed to be improved

- WorldSID-05F scores ref: WorldSID 5<sup>th</sup> Biofidelity Improvement Task Group meeting, 10/18/2016, attachment “ISO WS 5<sup>th</sup> Biofidelity Testing OSRP Update Plots and Scores 2NOV2016.pdf”
- SID-IIs scores ref: minutes of OSRP SID-IIs Upgrade Task Group meeting, 5/25/2006

# NHTSA Biofidelity Evaluation Methods

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3 tests in each test condition

- WorldSID-05F Mod Kit
- SID-IIs BLD

Scaled from 50<sup>th</sup> male to 5<sup>th</sup> female:

- Impactor mass & size
- Sled walls

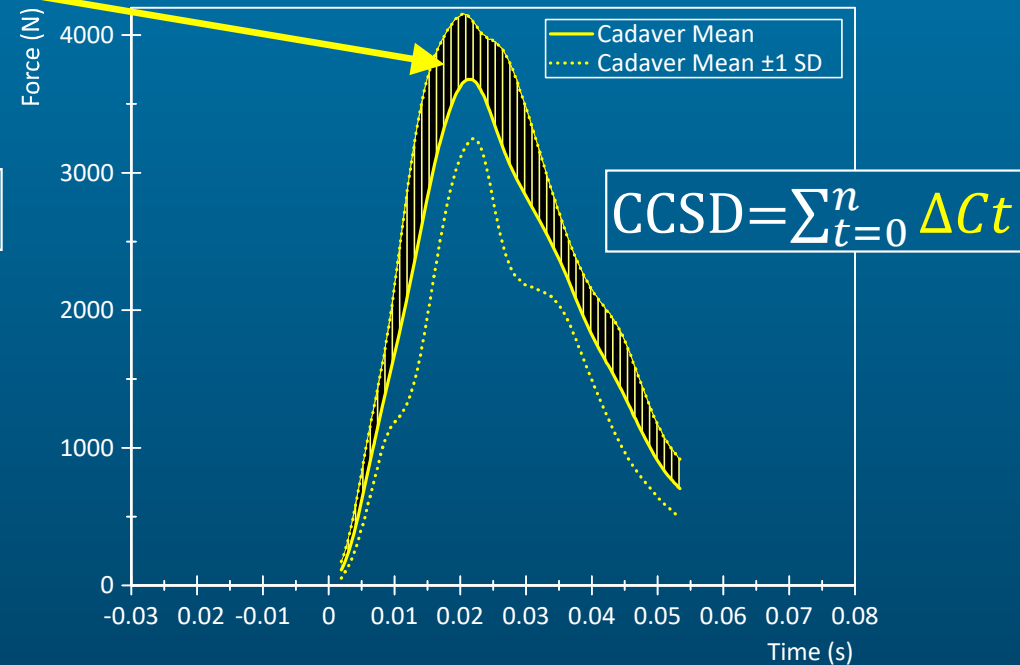
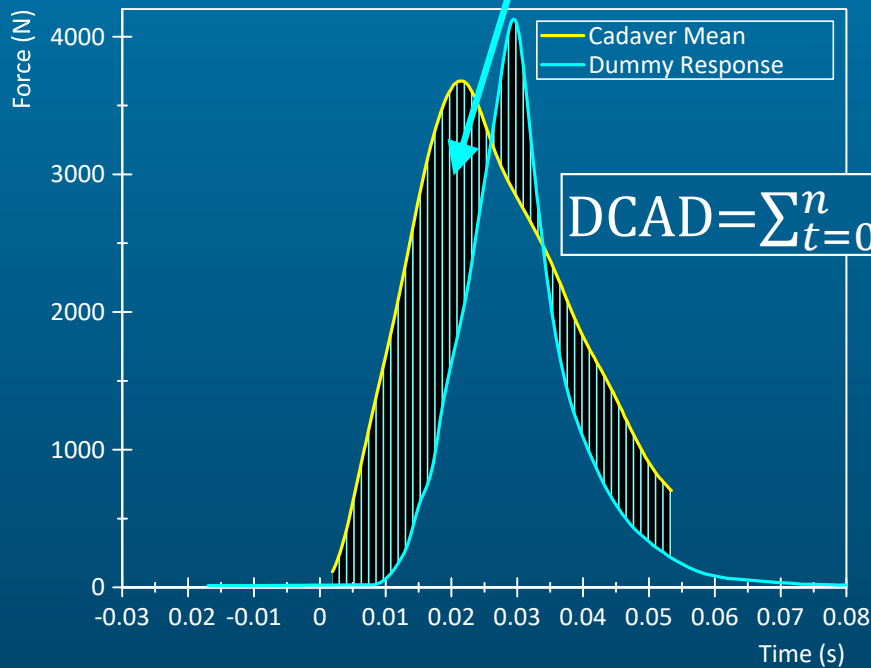
New side impact biofidelity targets for small female

- New normalization methods
- New response scaling methods

Body Region	Test Condition
Shoulder	4.4 m/s Bolte Lateral Impact
	2.5 m/s Shaw Lateral Impact
Thorax	2.5 m/s Shaw Oblique Impact
	4.5 m/s Rhule Lateral Impact
	4.5 m/s Rhule Oblique Impact
	6.7 m/s Rigid-Wall Sled Test
	6.7 m/s Padded-Wall Sled Test
	8.9 m/s Padded-Wall Sled Test
	6.7 m/s Rigid-Wall Sled
Abdomen	6.7 m/s Padded-Wall Sled
	8.9 m/s Padded-Wall Sled
	6.7 m/s Abdomen-Offset Sled
	6.7 m/s Rigid-Wall Sled
Pelvis	6.7 m/s Padded-Wall Sled
	8.9 m/s Padded-Wall Sled
	6.7 m/s Pelvis-Offset Sled
	6.7 m/s Rigid-Wall Sled

# NHTSA Biofidelity Evaluation Methods

$$BRS \text{ score} = \frac{DCAD}{CCSD} = \frac{\text{Dummy Cumulative Absolute Difference}}{\text{Cadaver Cumulative Standard Deviation}}$$



Lower BRS score means better biofidelity

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$$\text{BRS score} = \frac{DCAD}{CCSD} = \frac{\text{Dummy Cumulative Absolute Difference}}{\text{Cadaver Cumulative Standard Deviation}}$$

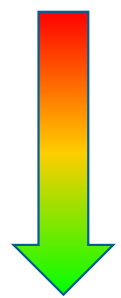
- BRS calculation period =  $t_0$  → time of the cadaver mean peak
- Dummy curve phase aligned
- If dummy curve peak was not included → calculation period was increased
- BRS score calculated
- Supplemental information → dummy phase shift, cadaver max & avg phase shifts

$$\text{Peak only score} = \frac{\text{Abs}(\text{Dummy Response Peak} - \text{Cadaver Mean Peak})}{\text{Cadaver Std.Dev.}_{\text{Avg upper 80\% of Cadaver Mean}}}$$

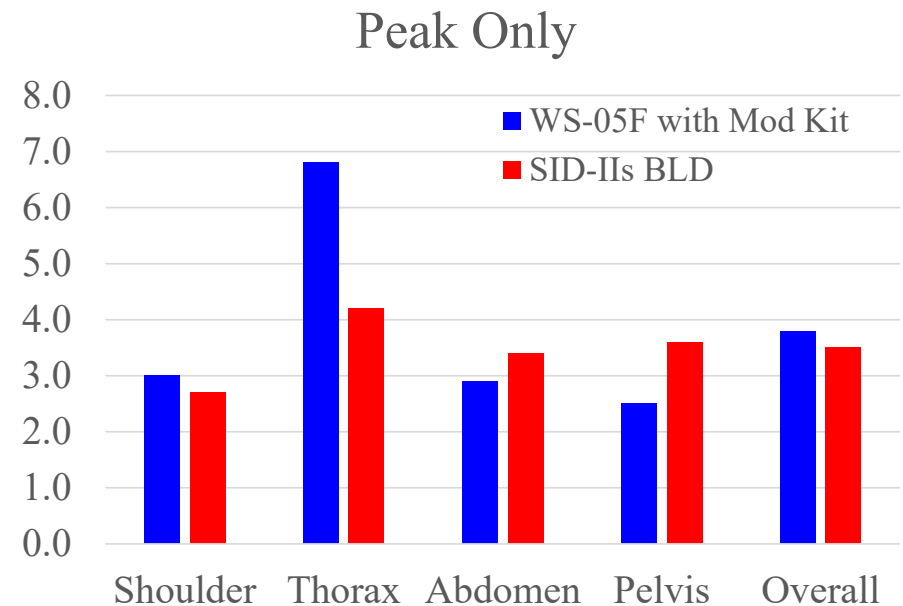
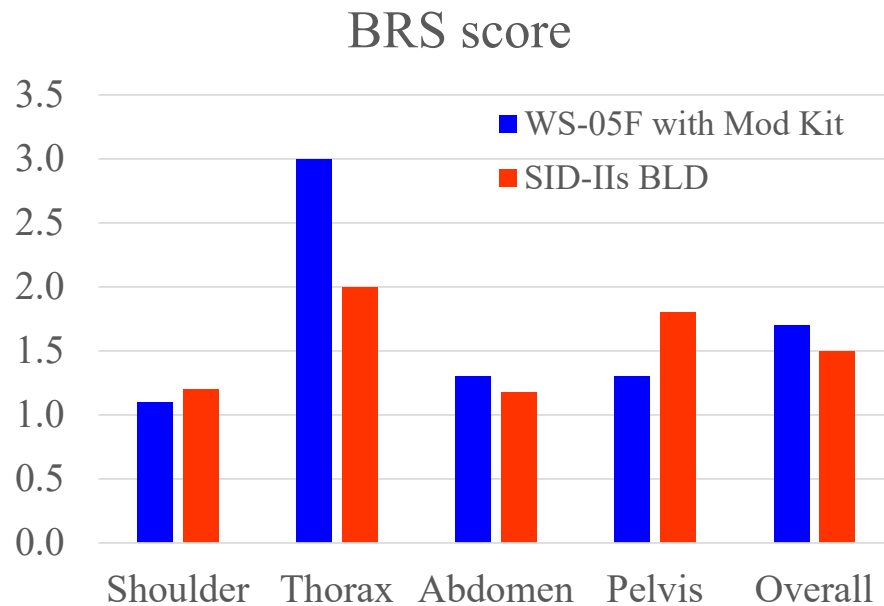
- No phase alignment of dummy curve
- Supplemental information → difference between cadaver and dummy peak times

# NHTSA Biofidelity Evaluation Results

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Lower score is better



WorldSID-05F thorax needs improved biofidelity

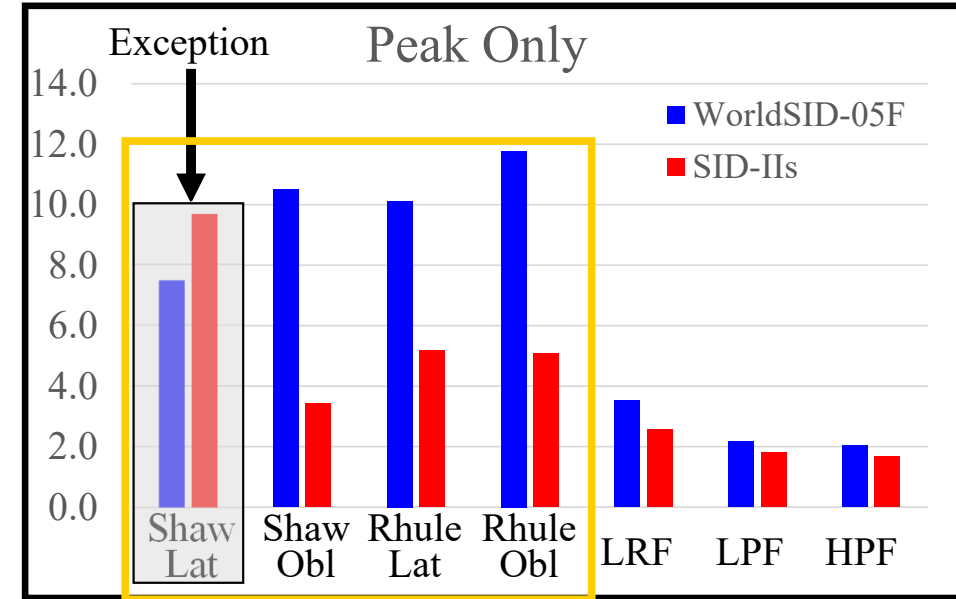
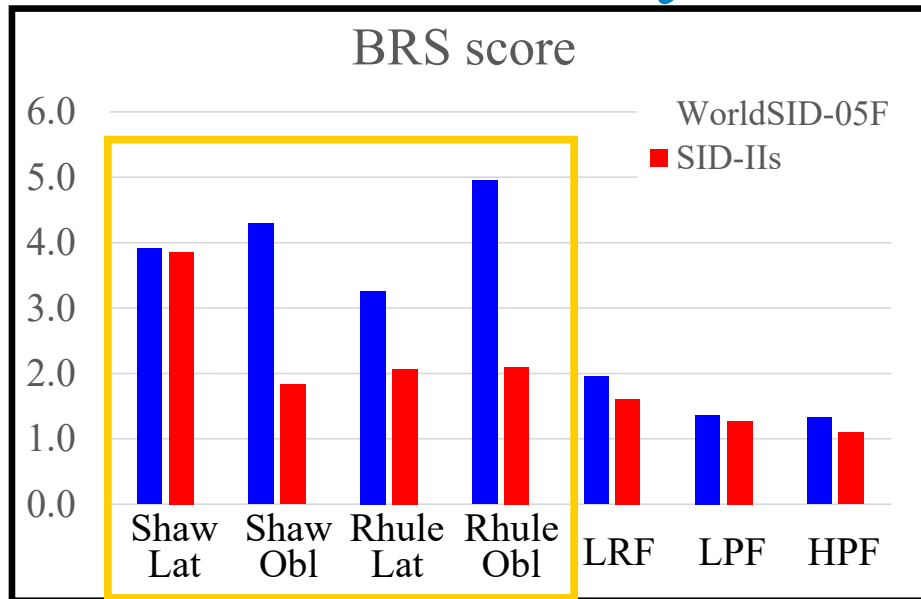


# Thorax Biofidelity Results

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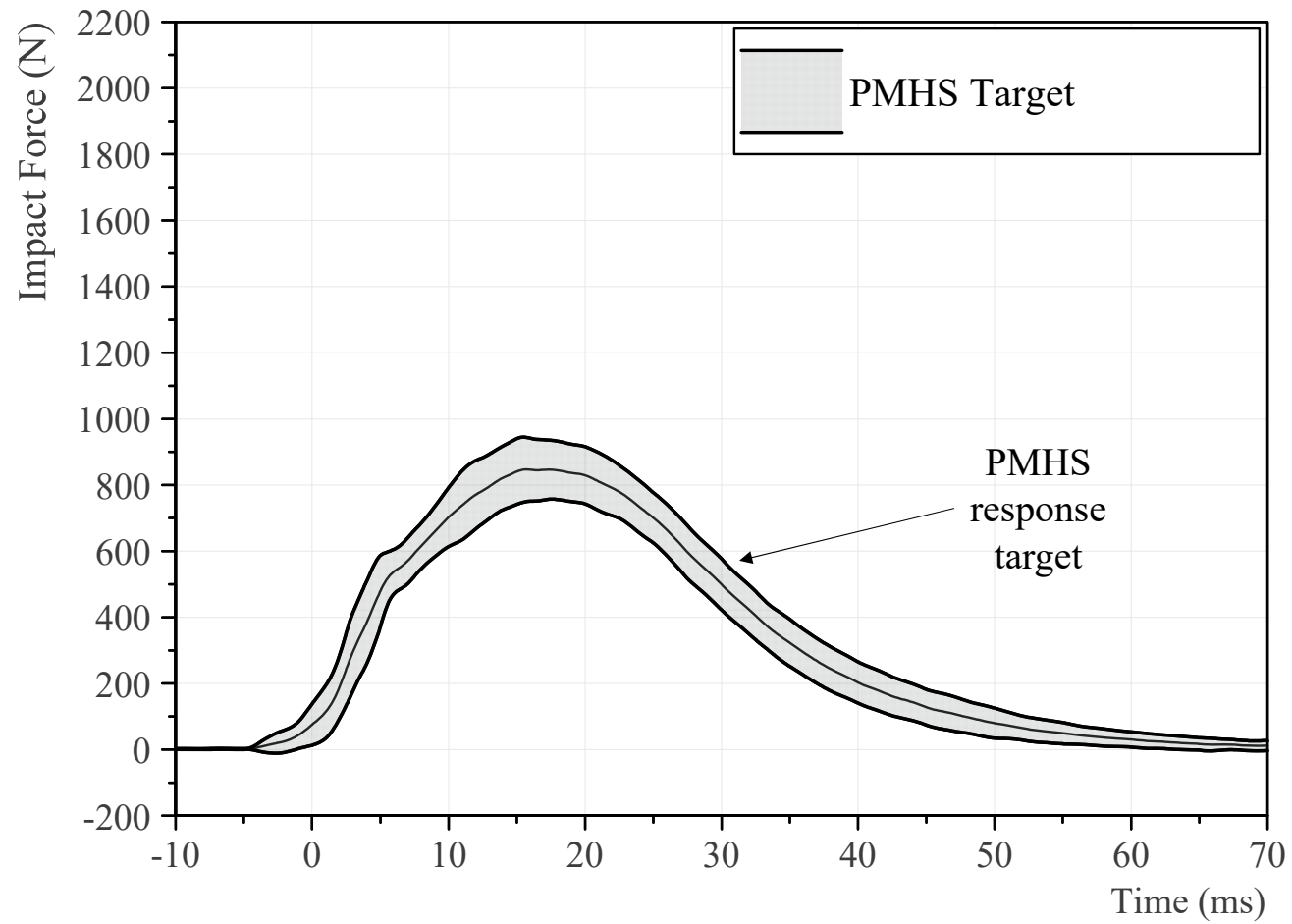
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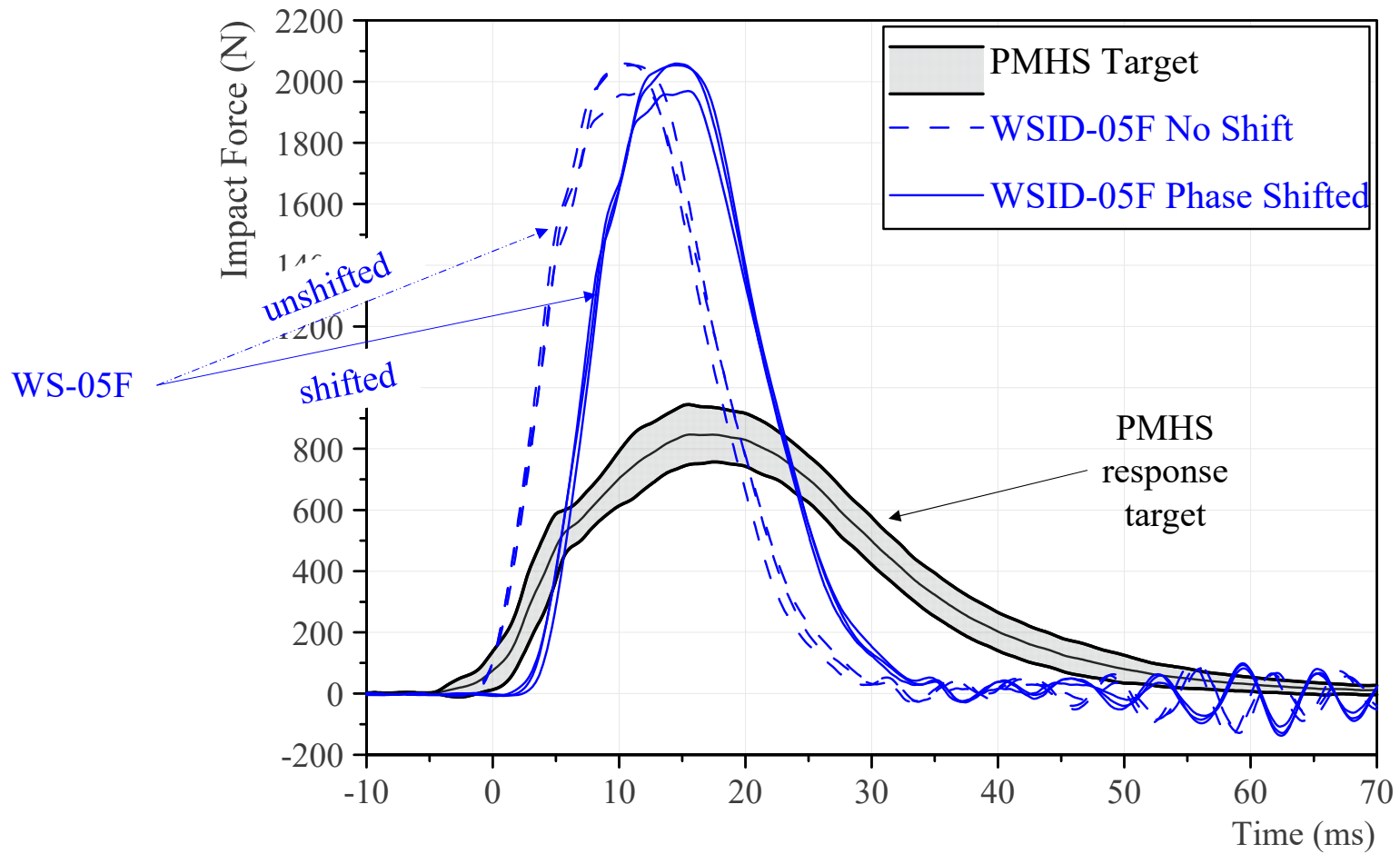
## Overall Thorax Body Region scores

BRS score		Peak Only	
WS-05F	SID-IIs	WS-05F	SID-IIs
3.0	2.0	6.8	4.2

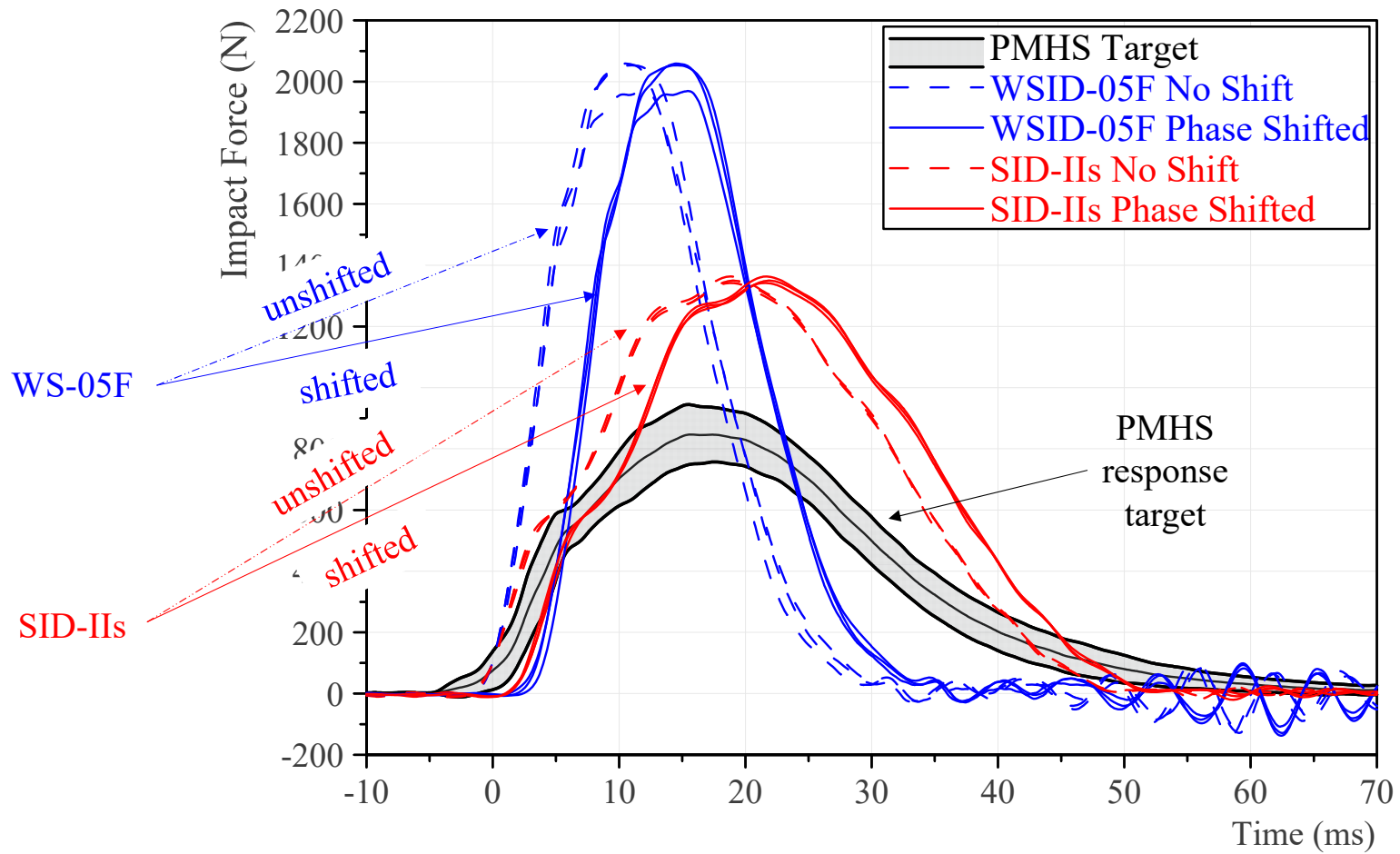
## 2.5 m/s Shaw Lateral Thorax Impact Test



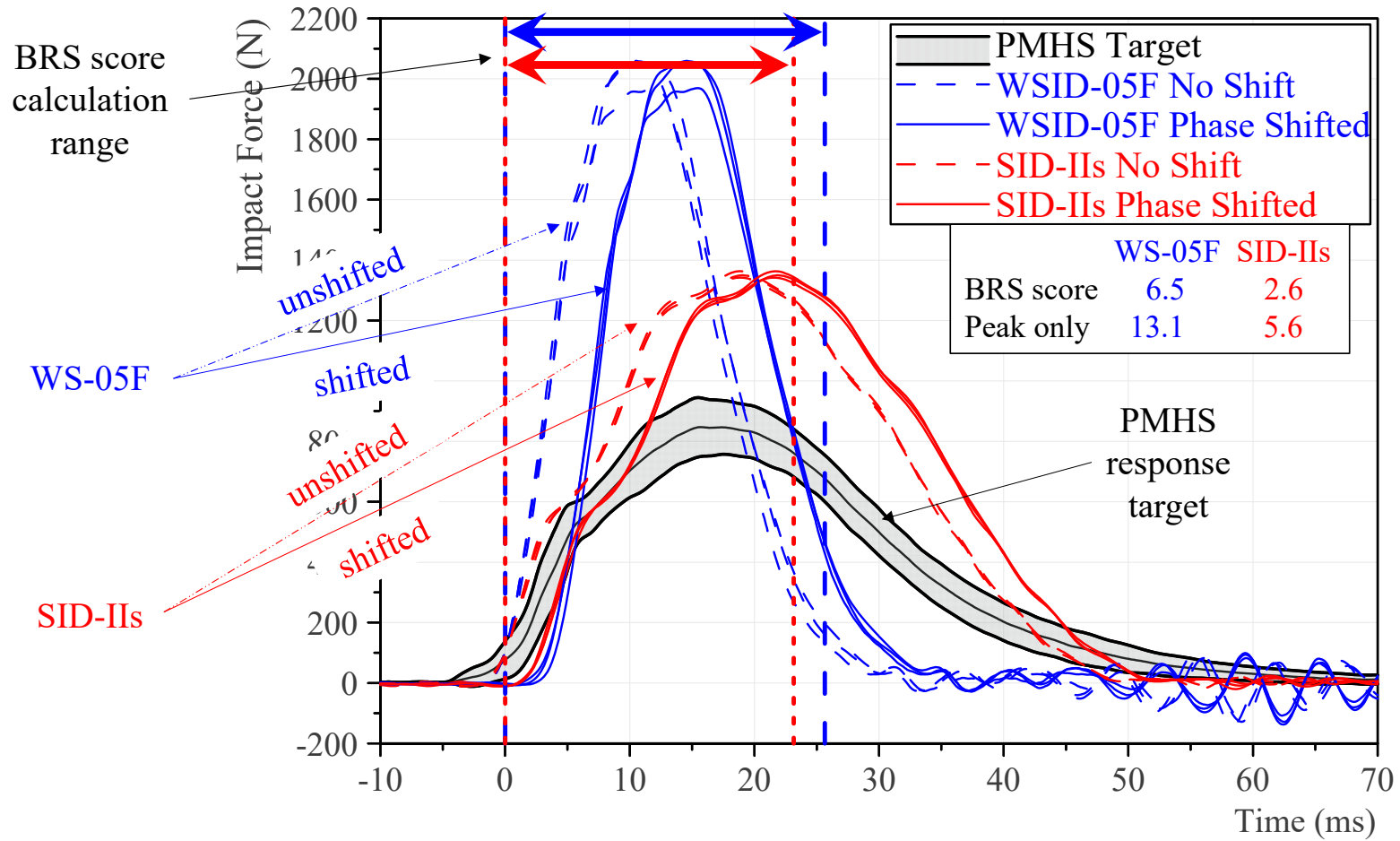
### 2.5 m/s Shaw Lateral Thorax Impact Test



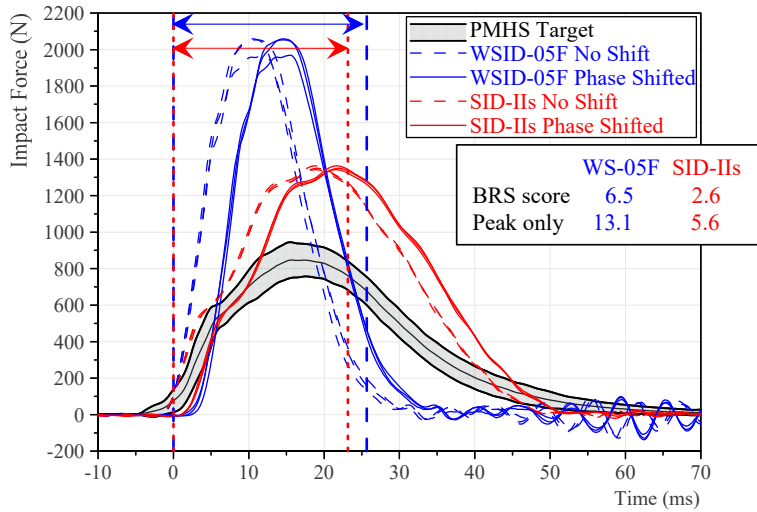
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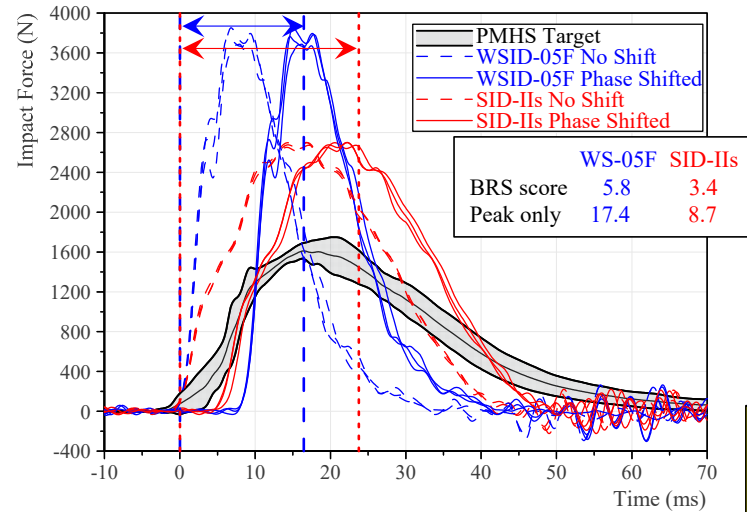
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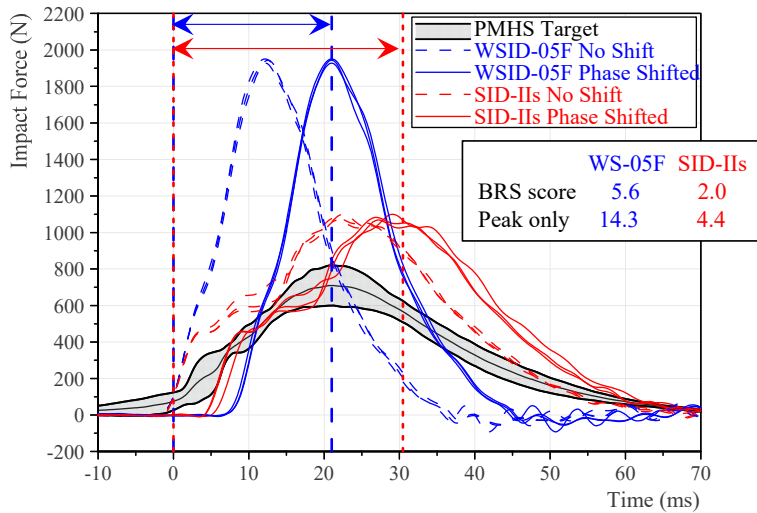


4.5 m/s Rhule Lateral Thorax Impact Test

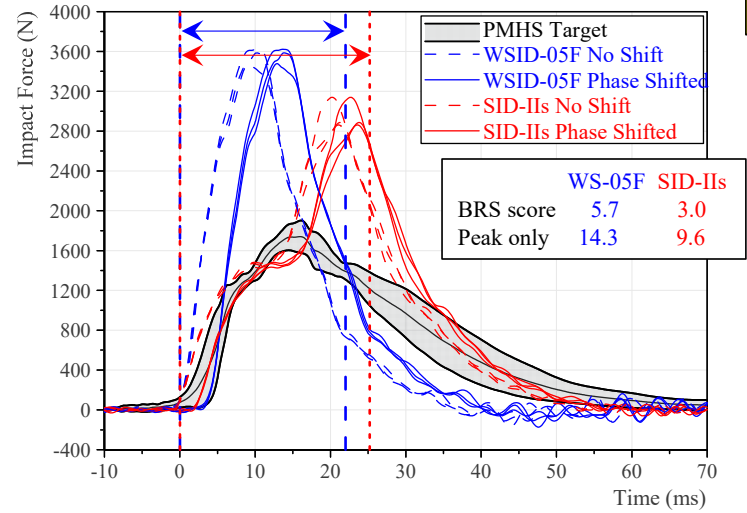


BRS score calculation  
Range  
↔

2.5 m/s Shaw Oblique Thorax Impact Test

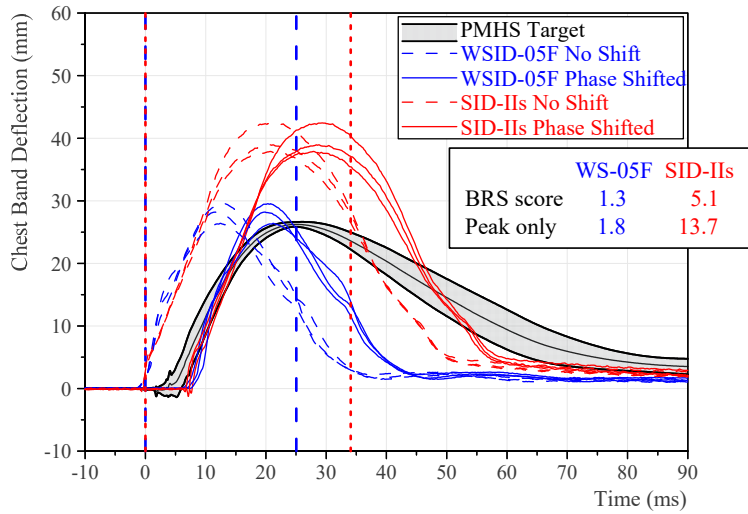


4.5 m/s Rhule Oblique Thorax Impact Test

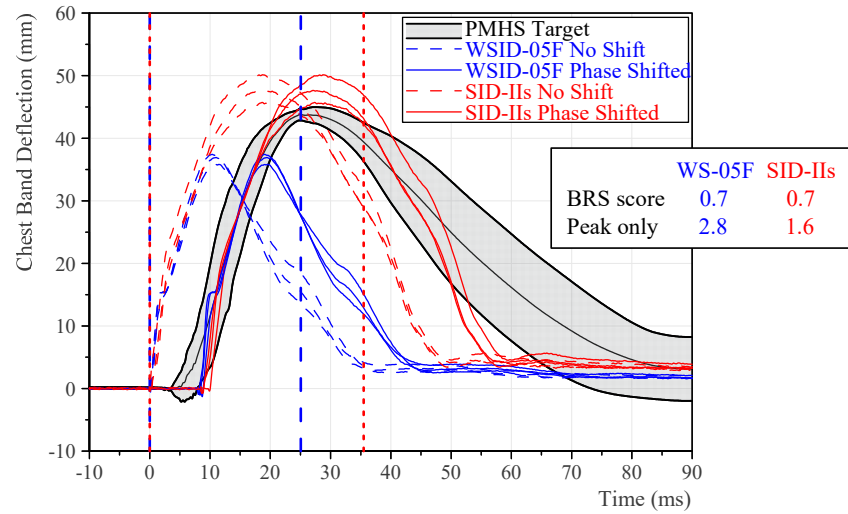


WorldSID-05F thorax is too stiff

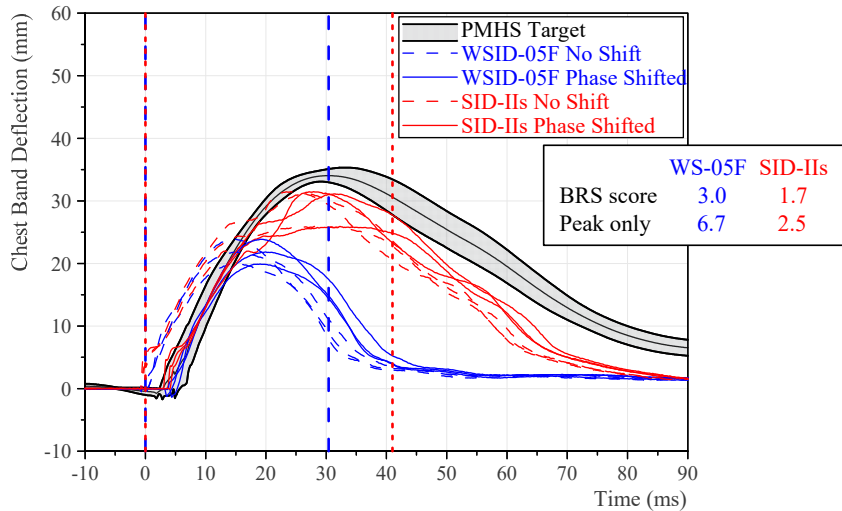
2.5 m/s Shaw Lateral Thorax Impact Test



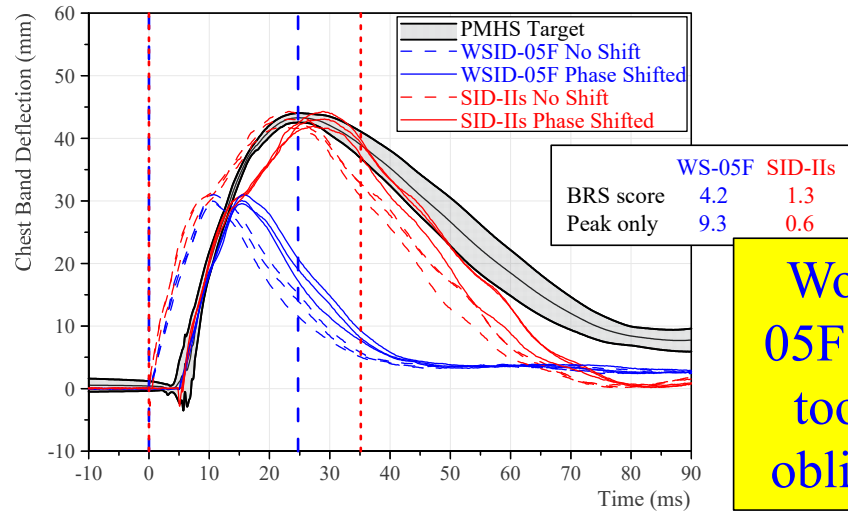
4.5 m/s Rhule Lateral Thorax Impact Test



2.5 m/s Shaw Oblique Thorax Impact Test



4.5 m/s Rhule Oblique Thorax Impact Test



WorldSID-05F thorax is too stiff in oblique tests

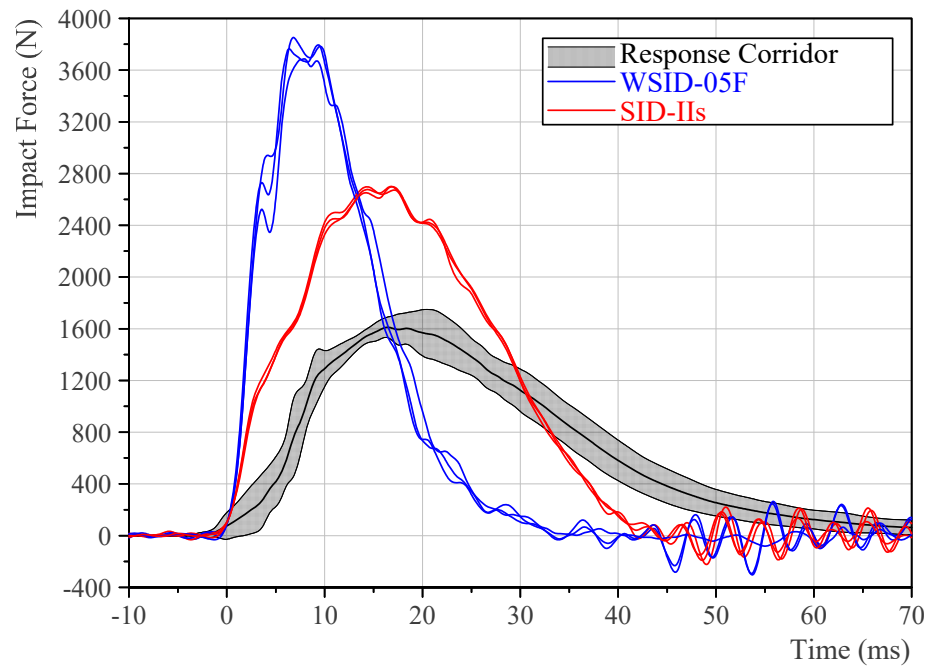


# Thorax Qualification Response Over Time and Corridor Comparisons

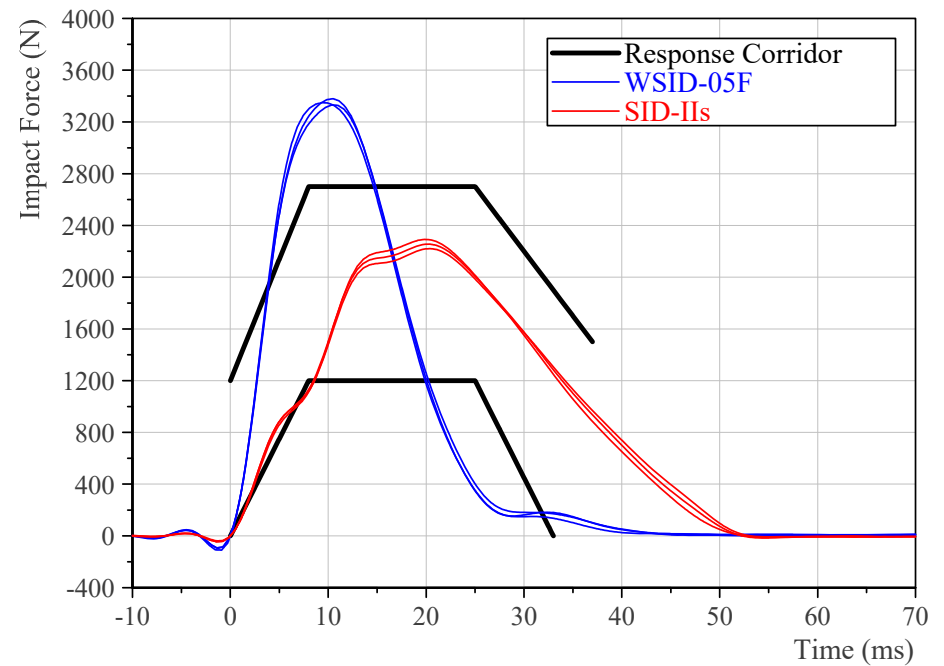
Test	Mass (kg)	Face (mm)	Impact speed (m/s)
Thorax without arm qualification test	13.97 +/- .023	120.7 ± 0.25	4.2-4.4
ISO 9790 Thorax Test 1 biofidelity test	14.0	125	4.3
Rhule lateral thorax impact biofidelity test	13.8	125 high x 305 wide	4.5

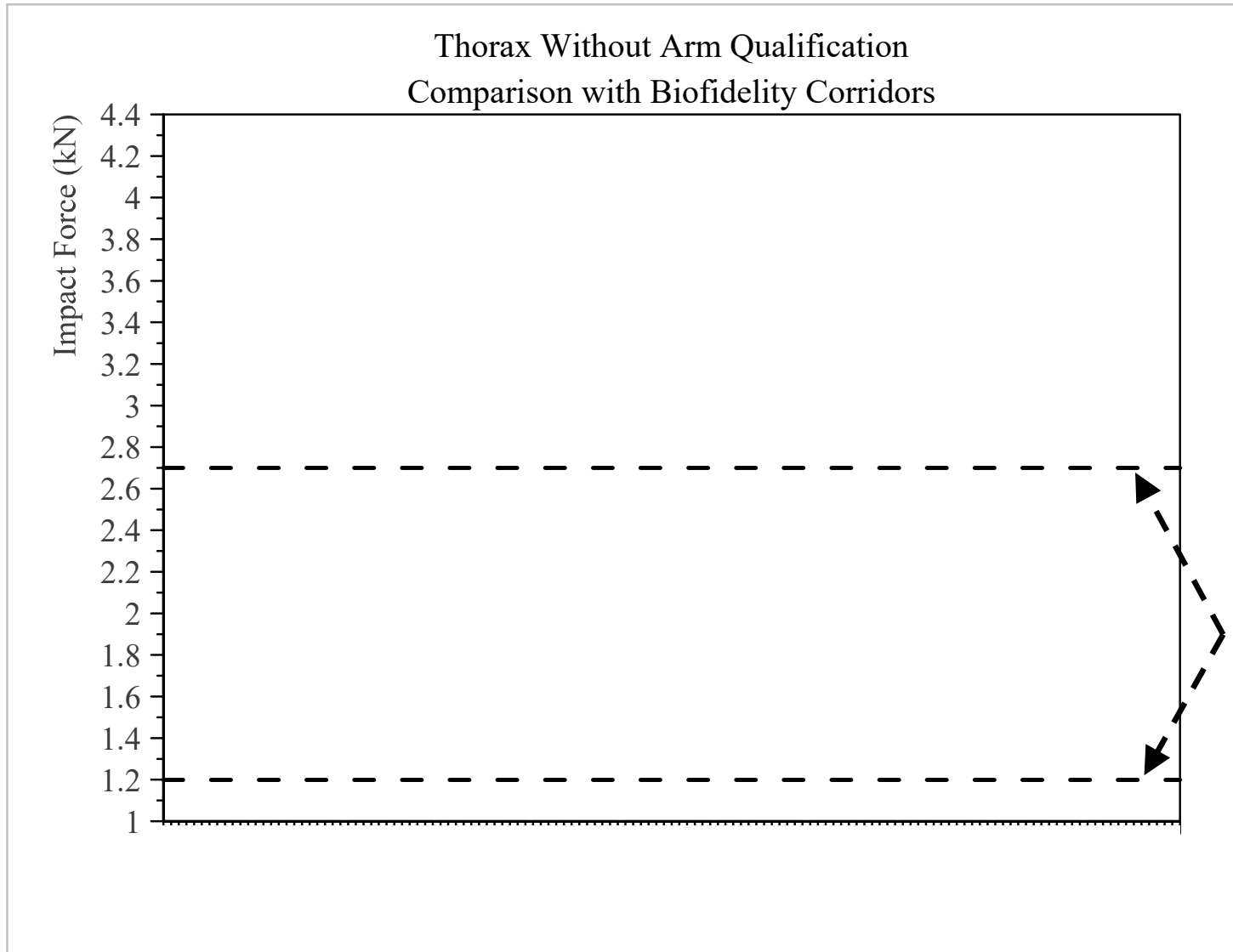
# NHTSA & ISO Lateral Thorax Impactor Biofidelity Tests

4.5 m/s Rhule Lateral Impact Test



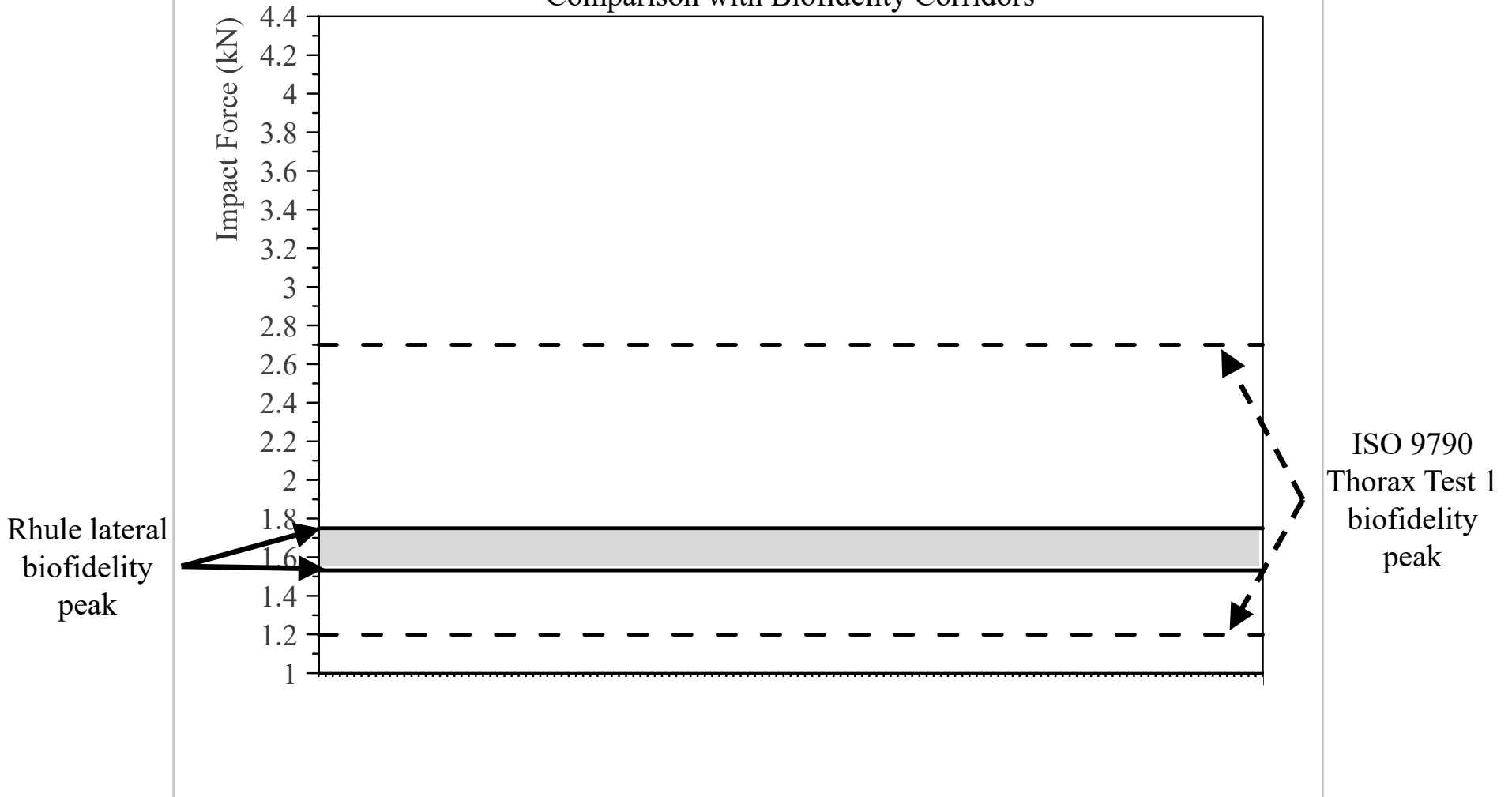
4.3 m/s ISO 9790 Thorax Test 1 Lateral Impact Test



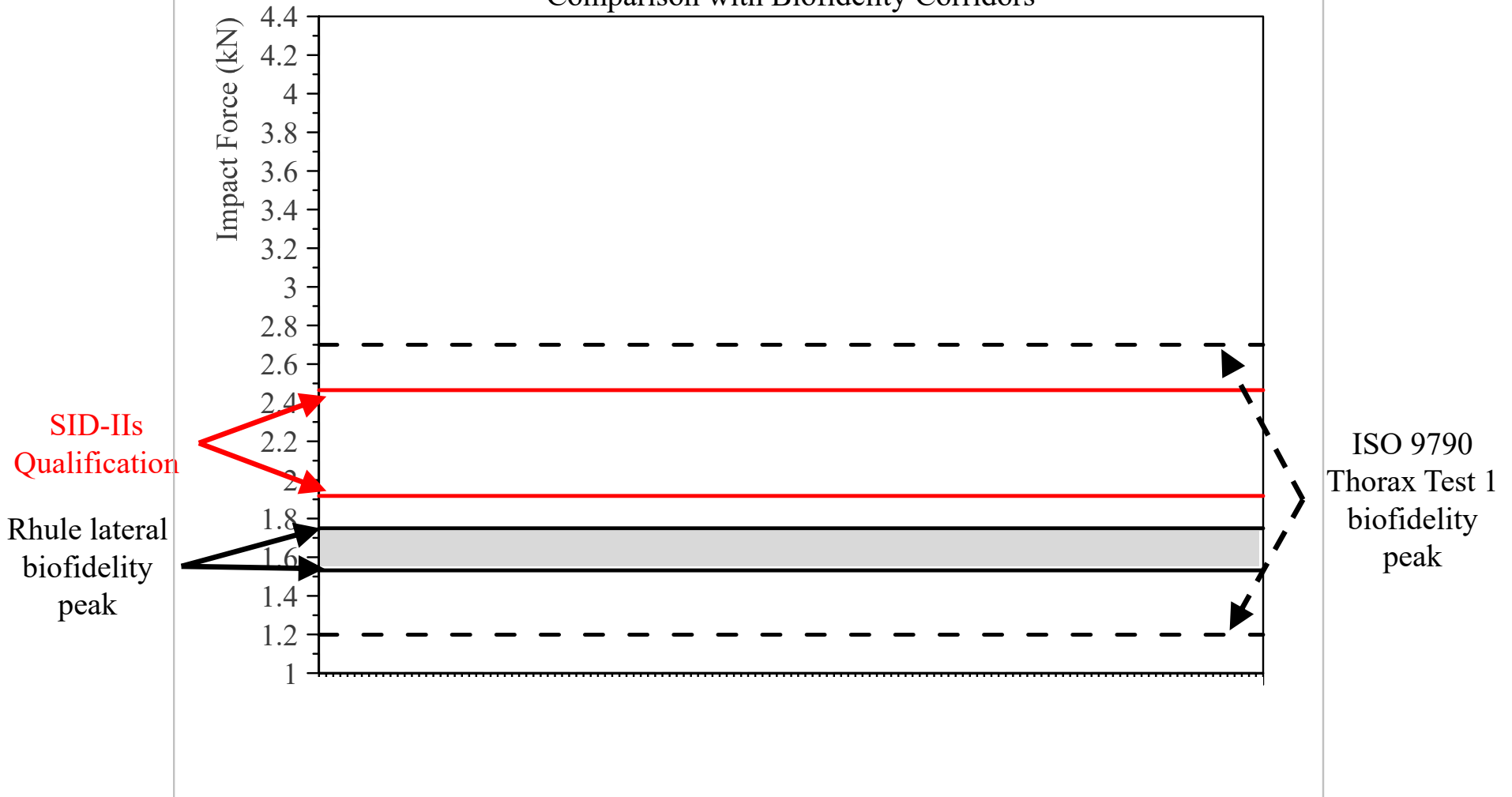


ISO 9790  
Thorax Test 1  
biofidelity  
peak

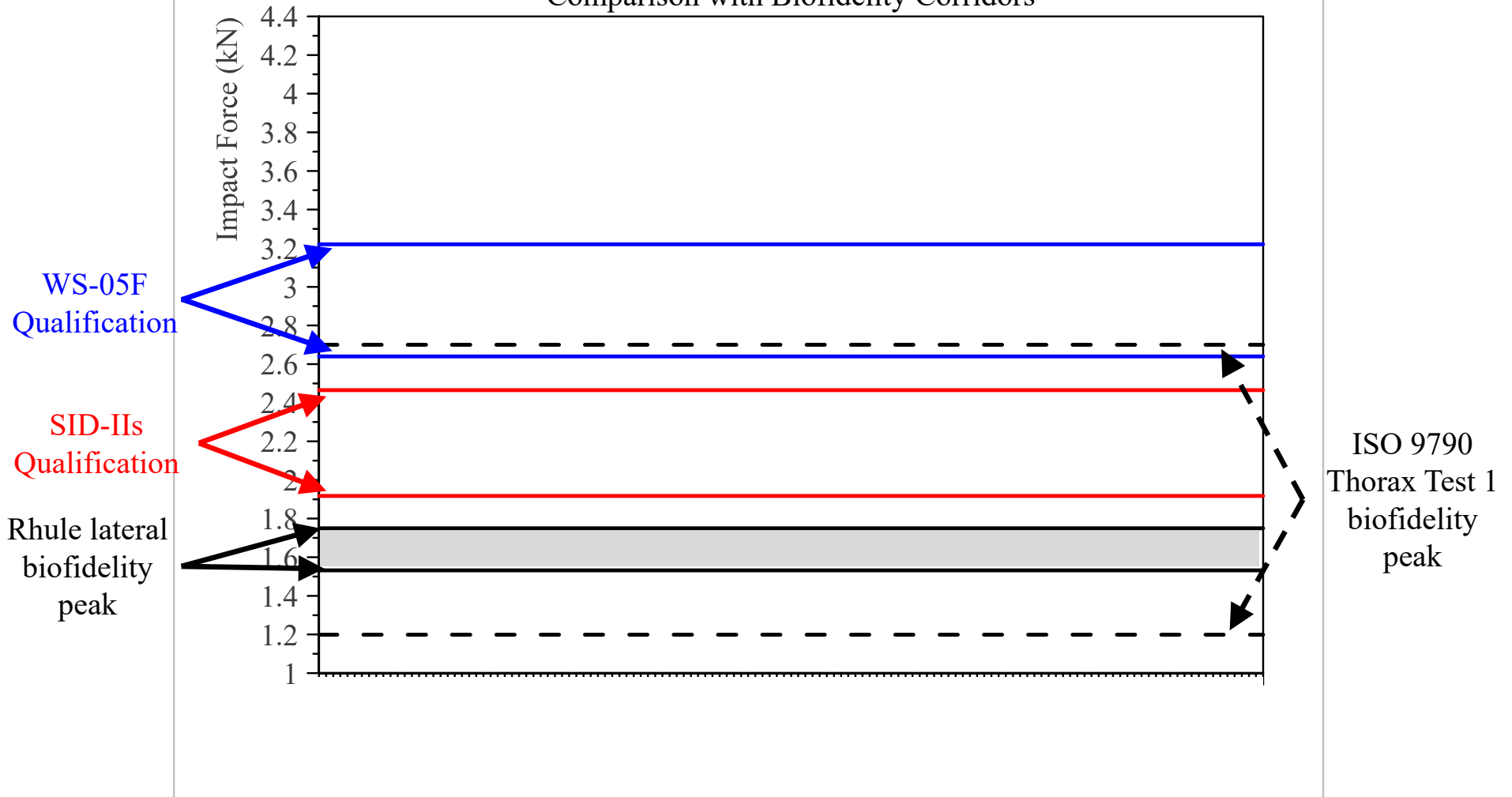
### Thorax Without Arm Qualification Comparison with Biofidelity Corridors



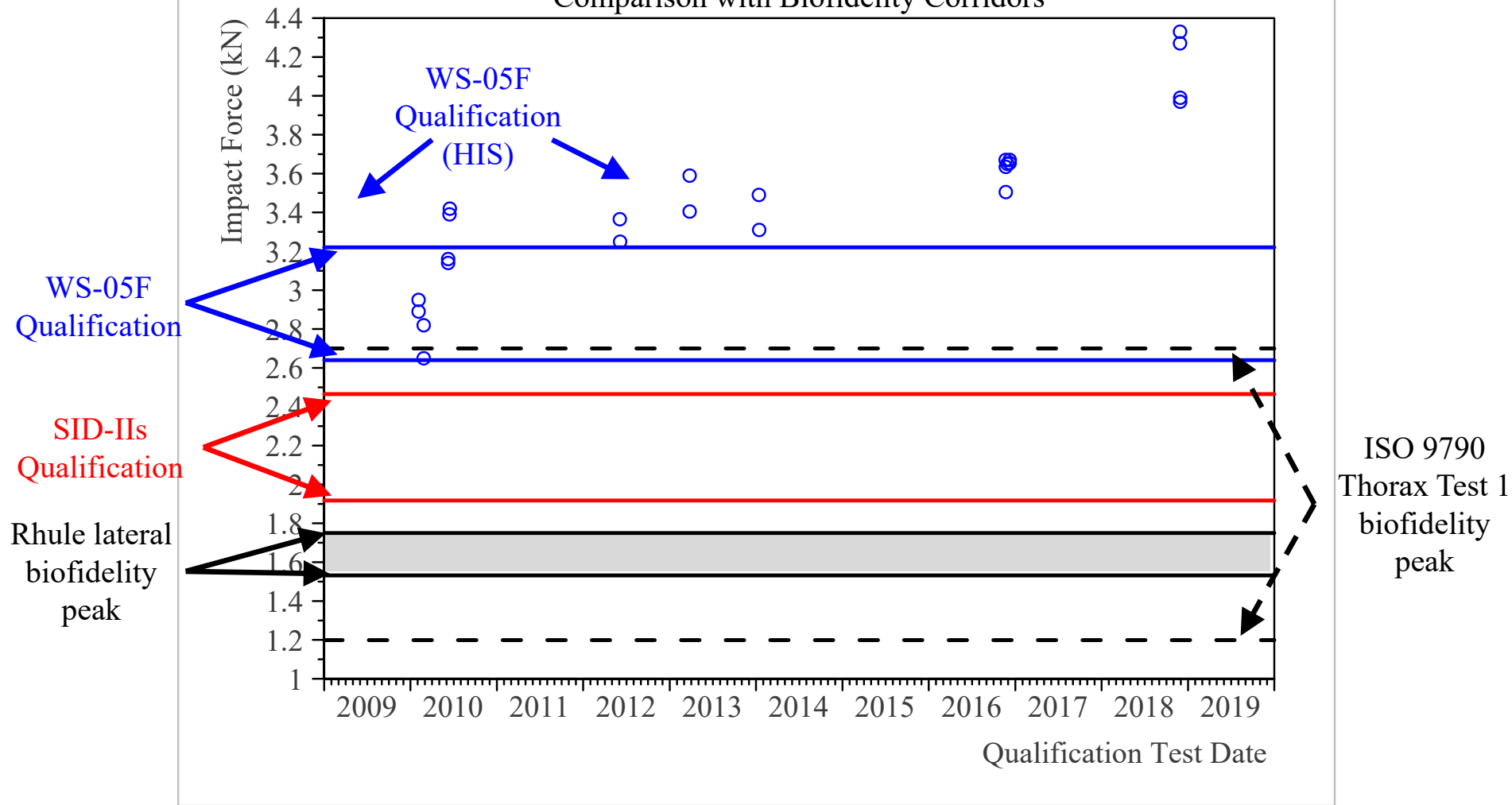
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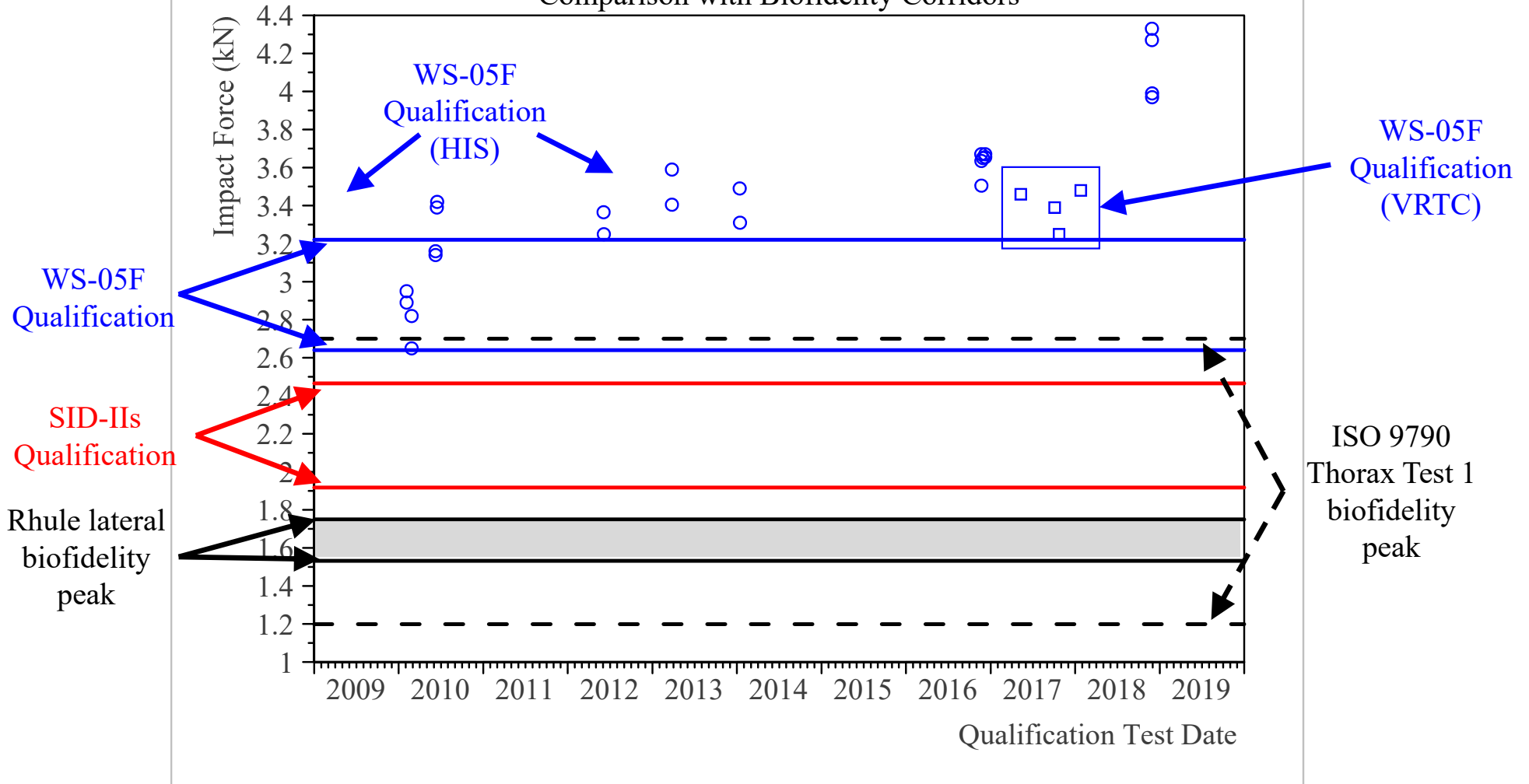
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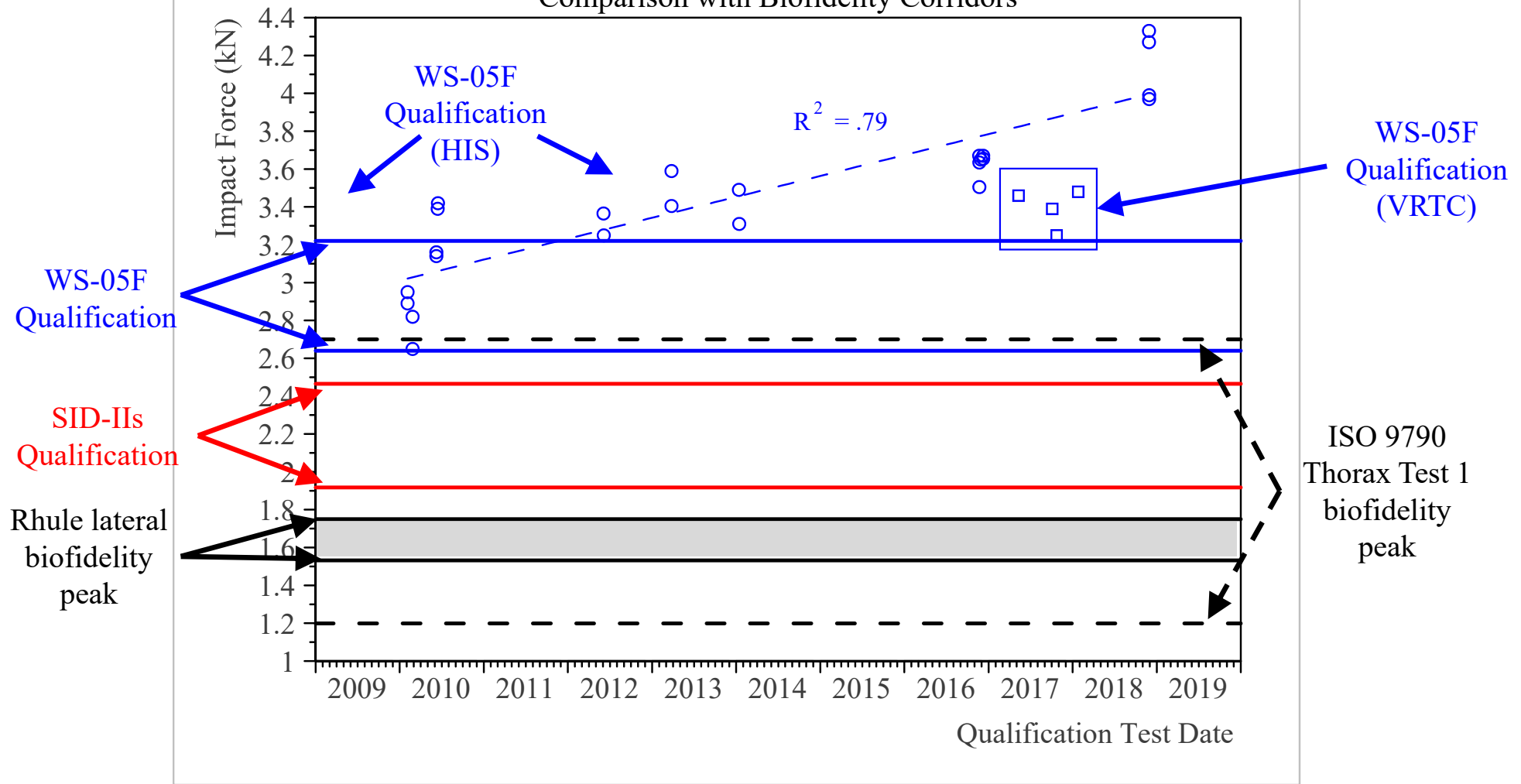


### Thorax Without Arm Qualification Comparison with Biofidelity Corridors





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- Overall biofidelity results
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- WorldSID-05F qualification corridor is too stiff
- WorldSID-05F qualification responses have been getting stiffer over time



# Biofidelity Evaluation of WorldSID-05F with Mod Kit and SID-IIs BLD

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